INTERNATIONAL
TSUNAMI
INFORMATION
CENTER

INTERGOVERNMENTAL OCEANOGRAPHIC COMMISSION
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МЕЖПРАВИТЕЛЬСТВЕННАЯ ОКЕАНОГРАФИЧЕСКАЯ КОМИССИЯ

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NEWSLETTER

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The ITIC Newsletter bring news and information to tsunami researchers, engineers, educators, community protection agencies and governments in 43 countries. We welcome your news, reports, papers, or abstracts.

The Most Amazing Tsunami in History (by Hisashi Miyoshi)

It is known in history that three tremendous tsunamis were caused by earthquakes the magnitudes of which were only 7.5 or so.

The recent one occurred off Unimak Island, Alaska and attacked Hawaii severely on April 1, 1946. Many people talked and wrote about this tsunami, and its size. We may, however, add that somewhere on Unimak Island, the tsunami might have reached heights greater than that reported, because only few people lived on this island and observed the tsunami.

The second is the one that attacked Sanriku, Japan and killed some 27,000 people on June 15, 1896. Concerning this tsunami, there are many reports, data and episodes. We need not here, therefore, introduce this tsunami.

The earliest one is that of April 24, 1771, near the Ryukyu Islands. Several researchers have written papers about this tsunami. They could not, however, use airplanes and did not visit the southernmost islands of the Ryukyu Chain which had been attacked by this tsunami. Mistakes in their descriptions were quite justifiable under the circumstances.

To understand this amazing tsunami, two items of background knowledge are necessary.

(1) The magnitudes of old earthquakes are, at least in Japan, decided from the areas in which people could feel the earthquakes, and old Japan also was crowded with people. The magnitudes of the old earthquakes in Japan are, therefore, rather reliable.

(2) Negro Heads. Large blocks of coral torn from the outer face of the reef and tossed onto the flat by storm waves or tsunami waves quickly become overgrown by a crust of black lichens; hence the name negro heads. They are a normal feature of exposed reef flats. Closer inspection has shown that some negro heads are erosional remnants of large coral heads or reefs that grew during a relatively

higher sea level and now remain in the position where they were originally formed. In Indonesia a few normal negro heads have been found on reefs in the extreme northeast of the archipelago, where typhoons are known to occur, but in the inland seas only examples of the EROSION TYPE are known. The only exception is where tidal waves raised during volcanic eruptions have devastated the coast, for instance opposite Krakatau on Java and opposite Poloeweh on Flores.* This phenomenon is a key to the mystery.

Near Formosa, there is the southernmost group of islands of the Ryukyu Chain. Ishigaki Island belongs to this group. On April 24, 1771, an earthquake, the magnitude of which was only 7.4, occurred to the south of this island. No direct damage by this earthquake itself was known. This earthquake was, however, accompanied by a tremendous tsunami. This tsunami attacked Ishigaki Island most severely. Damage was, of course, the biggest on this island. The tsunami also attacked Miyako Island which belongs to the next group of islands and lies considerably farther from the origin. This island is, unfortunately, flat, and was severely damaged.

This tsunami took more than 11,000 lives from these several small islands (not from the mainland of Japan)! And this figure is reliable, because these people had been the important taxpayers for the samurais of Satsuma and the records in detail were found. We may regard this tsunami as the strongest one caused by the earthquake, in history.

They say that the maximum height reached by the runup of this tsunami was some 85m on the basis of the data of survey. This survey was done by the samurais of Satsuma, the southernmost tip of Japan. Satsuma was the militarily strongest country in Japan at that time, owing to the heavy tax on the sugar canes cultivated on the Ryukyu Chain, and upset later the Shogun Tokugawa. It is natural, under the circumstances, the samurais' techniques of survey were advanced.

But we need not immediately believe in this figure. Though the survey of horizontal distance might be rather easy, that of the difference of heights across a very gentle slope might be difficult. There is, however, no doubt that the maximum height exceeded 50m, and may in some places have reached 60 to 85m.

We must here introduce the extraordinary capability of conveyance of this tsunami. The first figure shows the third biggest block of coral, conveyed by this tsunami. This block is as far as 2,500m from the nearest beach and is as high as 30m from the sea level. Its weight can be supposed to be some 750 tons. We measured the specific gravity of the fragments of this block by the Archimedes' principle, and found it was some 2.5. There are numerous blocks of coral in the lowlands on Ishigaki Island. Some of them lie as high as 50m from the sea level. The maximum height reached by the tsunami might be bigger than this figure, and might be, at least, 60m or so. And it might be possibly 85m, judging from this extraordinary capability of conveyance.

Some geologists claimed that these blocks were not transported but must be of the EROSION TYPE. We can disprove this. Traditions say that all these blocks were conveyed by the tsunami. And some of them were broken in pieces, because they had obstructed the roads. They confirmed at that time that none of them were rooted. The most reliable report was the one concerning the block which had located on the campus of the meteorological observatory and had been broken. We can, moreover,

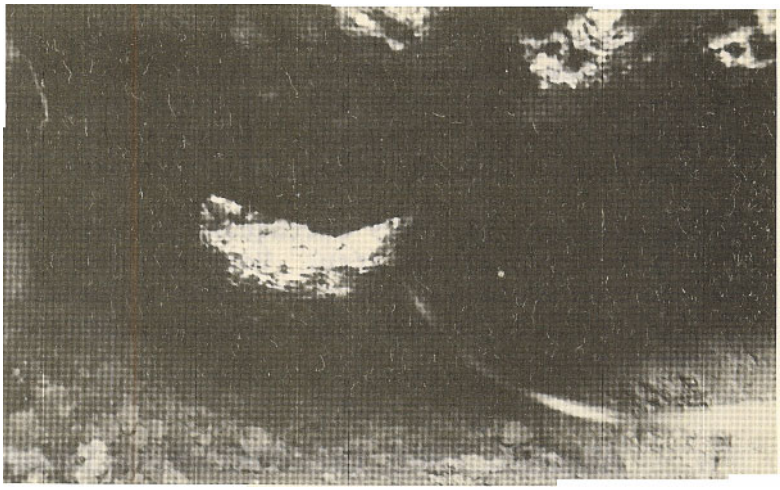
* Paragraph (2) from Kuenen, 1950.

easily find numerous shells of clams on the skins of these blocks, which suggest to us that they have been weathered only for the past several hundred years.

In order to prove it conclusively, we dug a wide tunnel under this block, and found it rested on red soil.

We show this tunnel in the second figure. There has been, here, no doubt that this surprising block had been conveyed by the tsunami which was the strongest in history.

Three supplementary items concerning this tsunami are of interest.



(1) The block shown in the first figure is, of course, one of the negro heads. These blocks are not, however, overgrown with the crusts of black lichens, but are crowned with many small trees.

(2) Taketomi Island is smaller and nearer to the origin of the tsunami than Ishigaki Island. This island is, however, utterly protected by the coral barrier, and sutstained no damage.

(3) The turbid waters passed through the several parts of Ishigaki Island. After the tsunami, the islands became, therefore, very unsanitary, and were highly malarial areas for a long time.

NEWS EVENTS

Japanese Scientist Visits ITIC

ITIC was pleased to welcome on December 14th, Dr. Norio Yamakawa of the Meteorological Research Institute, Tokyo. Dr. Yamakawa, Chief Seismologist of the Seismology & Volcanology Division, is developing an ocean bottom seismograph observation system, for installation in Japan. The system includes a series of seismic sensors to be laid on the sea bed, and to be interconnected by co-axial cable leading to a shore monitoring station. The system of sensors would extend 200 kilometers out to sea, and would measure tsunamis as well as earthquakes.

Data will be transmitted from the shore station to the appropriate earthquake and tsunami center. It is hoped to install this ocean bottom instrumentation in a seismically active area near Amae Zaki, about 200 km southwest of Tokyo.

The system could have benefit not only in providing more rapid warning of a locally generated tsunami to the local coastal areas, but also assist in providing rapid information of an impending threat to more distant parts of the Pacific. In addition this new technology, once proven, could have application in developing more automated sensing systems in other parts of the Pacific.

Earthquake and Tsunami Summary

The last three months has been an exceptionally quiet period, with only one earthquake of significance in each month.

On December 20 a magnitude 6.5 earthquake epicentered in the seismically active zone southwest of Vancouver Island was registered. The Tofino tide gauge, an automated station that can be phoned by direct dialing was queried by Honolulu Observatory, and showed no tsunami was registered.

A magnitude 6.5 earthquake was recorded on January 6 in the Bismarck Sea, north of Papua-New Guinea. No tidal station in the immediate area is available to the Honolulu Observatory for interrogation, and the nearest station, at Malakal, is presently out of service. Based on the seismic information alone, a press release was issued that no Pacific-wide tsunami had been generated.

On February 19 a 6.9 earthquake occurred in the far western Aleutian Islands, 200 km southwestward from Attu. Honolulu Observatory issued a press release stating that the magnitude was not sufficient to generate a Pacific-wide tsunami. ITIC has requested tide records from gauging agencies, to see whether any tsunami waves were produced.

REPORTS FROM INTERNATIONAL TSUNAMI INFORMATION CENTER - HONOLULU

ITIC Summary Report for 1976

The year 1976 has been an active and productive one at the International Tsunami Information Center. In February the Director and Associate Director participated at Lima in the fifth meeting of the International Co-ordination Group for the Tsunami Warning System in the Pacific (ITSU-V), out of which came recommendations providing guidelines for the work at the Center.

Following the meetings, liaison visits were made to Panama, Costa Rica, Nicaragua, El Salvador, Guatemala, and Mexico, to develop communication and participation in tsunami warning activities.

With the support of the Intergovernmental Oceanographic Commission, three scientists were able to spend 6-weeks periods at ITIC: Mr. Pedro Cabezas from Ecuador, Mr. Masahiro Kishio of Japan, and Dr. Victor Badillo from the Philippines.

ITIC monitored the operation of the Honolulu Observatory, during an active seismic year in which more than 30 earthquakes merited investigation for possible tsunami action. The Center also continued its co-operation with Chile, Peru, and Ecuador, in developing proposals for UN support of a regional tsunami warning system, which would provide greater protection for the South American coast.

As a result of the ITSU-V meeting, two proposals were prepared and submitted for UNEP support, one for a pilot program to study harbour response to tsunamis in South America, and the other to develop regional tsunami preparedness in the south and west Pacific.

The Center has initiated requests for tsunami data to agencies throughout the Pacific after major earthquakes, and has consulted researchers about their requirements for tsunami data. Publication of a new series, Tsunami Reports is in advanced planning, and data flow to the World Data Centers for Tsunamis will be systematized. ITIC is in addition supervising the contract for a compilation of tsunami bibliography, as a further aid to research. Co-operation has been arranged with the East-West Center of the University of Hawaii to assist in the future with the production of educational films on tsunamis when funds are allocated.

Following the major tsunami of August 16 in the Philippines the Director and Associate Director visited the disaster areas around Moro Gulf in the Southern Philippines, to study and report on the effects of the waves. In addition they participated in the sessions on Natural Disasters, in the conference "Survival of Humankind -- The Philippine Experiment," at Manila. The opportunity to participate in this Conference led, incidentally, to improved communication and co-operation with participating agencies in countries of the south and west Pacific.

ITIC envisions another active year in 1977, and appreciates the support and co-operation that makes its work possible.

EDITORIALS AND LETTERS

The following note of remembrance was received from The National Science Development Board, Special Committee on Tsunami Warning System, Manila, Philippines, January 28, 1977.

It is with deep regret that we read in the December 1976 issue of the ITIC Newsletter the passing away of Dr. Gaylord R. Miller, Director of NOAA's Joint Tsunami Research Effort at the University of Hawaii and renowned tsunami research scientist.

The members of the Special Committee on Tsunami Warning System (SCTWS), NSDB took special note of this unfortunate item, specially those of us who had the opportunity of meeting and working with him. In behalf of the SCTWS members and myself, therefore, allow me to convey to you and thru you our sincerest consolences to Dr. Miller's family and colleagues.

Elvira O. Tan
Executive Secretary

TSUNAMI WARNING SYSTEM IN THE PACIFIC

Work Begins on Upgraded Hawaii Regional Tsunami Warning System

The National Weather Service and the National Ocean Survey have commenced work on the Island of Hawaii in support of an improved regional tsunami warning system for the Hawaiian Islands (see September 1976, ITIC Newsletter).

Mr. Mickey Moss and Lt. Greg Segur of the National Ocean Survey's Pacific Tide Party will be reinstalling tide gauges at Honuapo and Kailua-Kona on the island of Hawaii, this month. This tidal data will be telemetered to Honolulu Observatory in real-time via a modified VHF/UHF/hard wire telemetry system. Additionally, an offshore quartz tide sensor at Hana Bay on Maui island will be incorporated into the upgraded warning system.

The National Weather Service has also allocated substantial money for new electronics equipment for the operational center at Honolulu Observatory. Mr. Frank Takenouchi and Mr. Ed Behre, NWS Electronics Technicians, will be working both at the Observatory and in the field to rehabilitate and add new equipment to the existing telemetry and electronic systems.

It is expected the tide gauges at Honuapo and Kailua-Kona will be operational by April 1, 1977, with real-time data being transmitted to Honolulu Observatory by August 1, 1977. The Hana tide gauge should also be operational by this time.

Upon completion of this project, by December 1977, it is expected that this upgraded system will respond effectively to earthquakes and subsequent tsunamis, of local origin.

NATIONAL AND AREA REPORTS

Meeting of the USSR Tsunami Commission

Dr.'s S.L. Soloviev and A.A. Poplavsky have kindly submitted the following report to ITIC summarizing the recent meeting of the USSR Tsunami Commission. The report gives an indication of the extent of tsunami research in the Soviet Union, and is reproduced in full.

A regular meeting of the Tsunami Commission of the Joint Council for Seismology and Earthquakeproof Building (MSSSS) attached to the Presidium of the USSR Academy of Sciences was held in Moscow on March 11 and 12, 1976. Scientific reports, information on international cooperation in tsunami research and warning, and on other topics were heard.

The scientific reports dealt mainly with original results obtained by the authors during recent years. A number of reports were of an abstract character and rendered short accounts of research groups' activities for the past five years.

Recent years have greatly advanced theoretical studies of tsunamis carried out at the Oceanology Institute of the USSR Academy of Sciences, at the Marine Hydro-

physical Institute of the Ukrainian SSR Academy of Sciences, at the Radiophysical Research Institute (RPRI) and at other institutions.

A series of studies of tsunami excitation and propagation for several hydrodynamic models which simulated the phenomenon under study to various extent, has been carried out by Oceanology Institute scientists (S.S.Voyt, B.I.Sebekin, A.B.Odulo, V.D.Larichev, A.N.Lebedev - all the authors spoke). On the basis of linearized hydrodynamic equations the following problems have been studied:

- generation of tsunamis in an ocean of a constant depth by a disturbance of an arbitrary type;

- generation of inertia waves related to the Earth's rotation;

- applicability range for a long-wave model of wave generation and propagation;

- effect of the Earth's rotation and sea floor relief on long wave propagation in an ocean, including the case of a two-dimensional non-uniform sea floor relief;

- effects related to joint influence of density stratification and roughness of bottom relief during tsunami propagation; in particular, it has been found that this joint influence leads fundamentally to a possibility of generating inner waves with significantly greater amplitudes than those of surface waves.

Scientists of the Marine Geophysics Institute (L.V.Cherkesov, V.V.Knysh, V.F. Ivanov, M.V.Bahii, I.P.Lukina - the report was delivered by V.F.Ivanov) have done the following studies:

- tsunami wave transformation in a coastal area and over a sea ridge has been studied by a numerical method for non-linear equations;

- generation of waves of different types in an estuary of a complex shape has been studied within the framework of the linear theory of long waves;

- propagations of inner tsunami type waves in a two-layer and three-layer sea of a variable depth excited by a solitary or periodical surface wave has been studied for linear conditions;

- Korteweg-de-Vries type equations for a case of spatial movement of one-layer and two-layer liquid in a basin of a variable depth have been obtained.

The report by A.A.Dorfman (Sakhalin Complex Scientific Research Institute, Far East Science Centre, Academy of Sciences of the USSR) offered an approximated analytical solution for a plane and axis-symmetrical problem of long waves of a finite amplitude excited by displacements of the sea floor. The linear nondispersion theory of long waves is applied at the generation stage. The propagation is described by means of the Kortweg-de-Vries equation. The wave pattern is represented as a combination of solitons and wave packet with a high-frequency filling. Soliton amplitudes and phases are derived from the solution of a corresponding Sturm-Luiville problem. The wave packet intensity is calculated by means of applying the conservation of mass law.

The report by E.N-Pelinovsky and T.G.Talinova (RPRI) offers a calculation of height variation of a solitary great-amplitude tsunami wave for a smooth depth

change in non-linear equations. The depth of wave collapse and the wave amplitude at the moment of turning-over have been found. It has been shown that the approximated relation derived earlier for a single small-amplitude wave can be used for practical calculations of a wave height of any amplitude.

Methods of numerical simulation of tsunami propagation in a basin with a real floor topography have been developed extensively within recent years. Such methods make it possible to study practically the whole evolution of a tsunami in its propagation up to the run-up onto the shore.

Programs to calculate two-dimensional propagation of long waves (tsunamis) on the basis of linear and non-linear approximated models in a basin with an arbitrary floor topography have been developed at the Computing Centre of the Siberian Branch of the USSR Academy of Sciences (Yu.I.Shokin, L.B.Chubarov). And the initial disturbance may be given either arbitrary or calculated for specific location, mechanism and other parameters of an earthquake focus (A.S.Alekseev, V.K. Gusyakov).

Much work on applying numerical methods for zonation of the USSR Pacific coast has been done at the Leningrad Hydrometeorological Institute (V.R.Bukhteev, A. Nebrasov, N.L.Plink). Numerical methods were used to solve the non-linear problem of the shallow water theory in one-dimensional and two-dimensional cases for a given real basin floor morphometry. A "summarized" tsunami source in the form of a continuous 90 km wide band was given along the west slope of the Kurile-Kamchatka trench. The height of the initial disturbance was assumed to be 2 m. A refraction diagram for beams radiating at equal distances from one another perpendicular to the source front has been plotted. One-dimensional problem was solved numerically in each of the wave tubes. The condition for free run-off of the wave was provided at the sea ends of the tubes. A condition of non-run was given near the shore (at the 10-metre isobath). Calculated marigrams obtained at the 10-metre isobath provided data necessary for preliminary zonation of the Kurile-Kamchatka coast from the Kamchatka Bay to the Iturup Island as regards tsunami heights and periods.

Apparent tsunami periods do not vary along the coast greatly. It, however, may be due to the fact that the shape of the initial disturbance in all of these calculations was fixed. Therefore the properties of the Kurile-Kamchatka shelf as a partial filter for tsunami waves were studied separately. The above study resulted in distinguishing coastal areas off which the shelf "acts" as a resonance amplifier. Extreme level rises have been determined for some most unfavourable combinations of earthquake magnitude, of tsunami intensity and of the shape of the initial disturbance of the level.

The numerical calculation method for a two-dimensional (in plan) run-up has been successfully applied at the research sector of the "Hydroproekt" Institute (report by V.M.Lyatkher, A.N.Militeev).

Tsunami run-up for a case when a tsunami wave with a negative initial phase runs over the slope was also studied by means of the hydraulic simulation method at the Moscow State University (report by G.E.Kononkova and A.E.Reikhrudel). As a result, the following features have been established. The profile shape of the train of waves changes very little as it runs over steep slopes. A significant change of the profile shape occurs when a train of waves runs over a long gentle

slope. In this case formation of a peculiar "water cushion" due to collapse of the first crest is observed. This "cushion" significantly facilitates the motion of the crest that follow, it increases flow velocity on the originally dry shore, and the run-up size.

Two reports by A.A.Poplavsky dealt with main results of tsunami studies by the staff of the Laboratory of Tsunami of the Sakhalin Complex Scientific Research Institute, Far East Science Centre, Academy of Sciences of the USSR (S.L.Soloviev, V.A.Bernshtein, R.N.Burymskaya, Ch.N.Go, A.I.Ivashchenko, V.M.Kaistrenko, B.V. Levin, V.A.Orlov, A.A.Poplavsky, I.N.Tikhonov, N.A.Shchetnikov). During recent years, studies were done in the following main fields:

- hydrodynamics of tsunami generation;

- physics of a tsunamigeneous earthquake source;

- hydrodynamics of tsunami propagation;

- compilation and generalization of actual data on tsunamis;

- operative tsunami warning from seismological observation data at one point.

The problem of physical processes that occur in a water mass during an earthquake at the sea floor and enable a portion of earthquake energy to be transferred into the hydrosphere is of great importance for the tsunami problem. Wave motion that produces a perceptible tsunami at the shore is a long gravity wave in a deep sea zone. From the relationship between ocean depth and wave height and length it follows that wave propagation is accompanied by transfer of mass. This property of the wave motion under consideration which may be treated as existance of a non-zero constant horizontal component of a flow must be provided by the mechanism of tsunami generation.

In linear equations of the tsunami excitation problem, the above transfer of mass occurs provided the disruption of continuity in an earthquake source reaches the bottom, and the absolute values of the displacements on either side of the disruption are not equal.

Low-frequency disturbance with the above property may also occur when elastic displacements only propagate over the bottom, due to non-linear effects in a liquid medium. Since propagation velocity of a rupture in an earthquake zone is about twice the velocity of sound in water, propagation of a seismic pulse over the bottom is equivalent to flow-around of spatial distribution of the amplitude of this pulse by a supersonic liquid flow. And discontinuity surfaces similar to blast waves in gas are known to inevitably appear in the flow, which is essentially a non-linear effect. The role of these processes in tsunami origination is practically unstudied. Literature studies and small series of simulation experiments involving explosions in water carried out by the Sakhalin Complex Scientific Research Institute (SCSRI) in summer 1974 testify to the effect that the blast-wave mechanism of tsunami excitation is worthy of special study.

Tsunami propagation has been studied at the SCSRI to a limited extent, only as regards run-up onto specific coastal areas of Kurile Islands and Kamchatka (detailed tsunami zonation). Coefficients of tsunami amplification have been calculated

from amplitude energy as a function of a point at the water edge for the Kasatka, Malo-Kurilskaya and Yuzhno-Kurilskaya Bays by means of approximated methods taking into account the real topography of the sea floor and shore, the actual size of particles composing bottom and shore material.

By now, compilation of a catalogue of tsunamis in the Pacific Ocean has been completed (up to 1968). This catalogue is of maximum completeness and it will be a factual basis for further statistical studies in the tsunami problem.

Development of an algorithm system for automatic operative prediction of tsunamigeneity of an earthquake from seismic observations at one point is at the completion stage. The SCSRI is introducing this system to the tsunami warning service at the Yuzhno-Sakhalinsk Tsunami Station.

It was noted in the report by Ya.G.Birfeld (MSSSS) that the solid Earth, the hydrosphere and the atmosphere (ionosphere included) are a single oscillatory system which can be excited by both an earthquake and the hydrosphere's surface oscillations related to tsunami propagation. And small oscillations of the surface of the Earth or of an ocean result in a significant "oscillatory redistribution of ionization density" within the ionosphere, and this redistribution should be revealed by radiophysical observation methods. Observations of ionosphere disturbances related to earthquakes and tsunamis is planned to be made in the USSR.

The state of the tsunami service in the Far East and possible ways of improving it were dealt with in a short report by Yu.R.Orshansky, a representative of the Far Eastern Hydrometeorological Research Institute. Stating truly that the prediction procedure, calculation technique of tsunami wave parameters, state of the level observation network, means and methods of data transmission require to be improved, the speaker expressed his doubt that the aforesaid prediction of tsunami (not only of the event itself, but also of wave energy at a specific shore) can be achieved only from data on free surface rise and from current velocity values at a certain point and at a single level in an open ocean. Energy exchange between the surface gravity wave and the induced inner one in a real stratified ocean may turn out to be the reason for probable ambiguity. Therefore for reliable estimation of danger degree of a tsunami it is necessary to register such disturbances of physical fields within the ocean and in the atmosphere above the ocean, which would characterize the whole water mass as a single whole, - "integral parameters." According to the speaker, such parameters may be magnetic component of combined magnetohydrodynamic wave caused by the motion of the conducting medium (sea water) in the magnetic field of the Earth, redistribution of ocean electric fields, atmospheric cyclotron radiation,etc. According to preliminary estimations, in particular, the value of the magnetic field intensity within a magnetohydrodynamic wave should be of the order of $(10^{-6}-10^{-4})$ oersted. Such a value can be observed by existing magnetometers. Measurements of the above parameters and investigation into their prognostic possibilities are panned to be done by means of special marine expeditions.

As a result of a discussion of scientific reports and communications the Commission adopted a number of resolutions and proposals directed towards further development of tsunami studies in the USSR and towards improving research coordination among different groups. In particular, the Commission noted it as a positive fact that certain intensification of studies on tsunami was observed at the Oceanology Institute of the USSR Academy of Sciences, the Marine Hydrophysical Institute of the

Ukrainian SSR Academy of Sciences, the Leningrad Hydrometeorological Institute (LHMI), the Computing Centre of the Siberian Branch of the USSR Academy of Sciences (CCSB USSR AS), the Radiophysical Research Institute (RPRI), the Sakhalin Complex Scientific Research Institute, the Far Eastern Hydrometeorological Research Institute of the Hydrometeorological Service of the USSR, and other institutions.

The Commission recommended to strenghten the coordination of works for tsunami zonation of the USSR Pacific Coast among the responsible institutions (SCSRI, LHMI, CC SB USSR AS, RPRI), and it approved the list of fundamental measures towards improving the above coordination, compiled by representatives of those organizations.

The Commission considers it expedient to discuss at its next meeting a detailed report by representatives of the Far Eastern Hydrometeorological Institute on the program of research and experimental-designing works on the tsunami problem for 1976 - 1980.

The Commission has been proposed to meet for it next session in spring 1977.

Tsunami Symposium in Japan

A one-day symposium on tsunamis was held at Tokai University, Shimizu City on October 11, 1976. The lectures drew a large enthusiastic audience, and were reported seriously by newspapers and television.

Part of the interest resulted from past local experience with tsunamis. The region had experienced two magnitude 8.4 earthquakes and tsunamis in 1854. Another occurred on December 7, 1944, magnitude 8.0, the origin of which was inferred to be in the western half of that preceding region, but no earthquake has occurred in the eastern half since 1854. Some of the lectures considered the possible impending threat to the eastern zone, which includes the city of Shimizu.

The symposium was convened by Dr. Miyoshi, and 5 themes were presented. The contents of the lectures dealt with the following subjects:

Dr. Kozo Yoshida:	Necessity of the study of tsunamis.
Dr. Hisashi Miyoshi:	Theories connected with warnings.
Dr. Isamu Aida:	Tsunamis caused by landslides.
Dr. Tokutaro Hatori:	Characteristics of historical tsunamis, particularly related to the 1854 events.
Dr. Shigehisa Nakamura:	Results of experiments concerning harbour response to tsunamis.

ABSTRACTS AND RESUMES

Ocean Bottom Seismometer Study of the Kuril Trench Area

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NOAA-JTRE-166, HIG-76-9

Abstract

An ocean bottom seismograph was deployed on the seaward side of the Kuril Trench off Hokkaido, Japan in 5460 m of water, in August during the 1975 Joint Soviet-American Tsunami Expedition. During the seven-day period, S-P times were distributed in three groups: 19-24 sec, corresponding to aftershocks of the 10 June and 13 June 1975 earthquakes southeast of Nemuro, Japan and to earthquakes east of Sanriku, Japan; ∿30 sec, from south of Erimo Peninsula, Hokkaido; and ∿100 sec, from the Izu-Bonin Islands. Seven earthquakes, with hypocenters well determined by the land seismic net, are studied in detail. A shallow focus earthquake yields typical oceanic mantle velocities shallower than 50 km in the slab which dips under the Japanese archipelago. However, deeper focus earthquakes reveal anomalously high velocities ($V_p \geq 8.50$ km/sec, $V_s \geq 4.80$ km/sec) averaged over the upper 230 km, in agreement with the models of Utsu and Oliver and Isacks. Two deep earthquakes, whose paths lie in the Pacific Ocean asthenosphere, suggest a velocity 3% lower than that predicted by Jeffreys-Bullen, in agreement with the above models. Spectral analysis of S arrivals suggests Q_s values of 1000-1500 for nearby earthquakes (S-P < 43 sec) and 4000-6000 for longer distance earthquakes, implying an unusual attenuation mechanism for long travel paths, which enhances the high frequencies.

Tsunami Wave Runup Heights in Hawaii

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NOAA-JTRE-161, HIG-76-5

Abstract

This report presents maps of the shorelines of the Hawaiian Islands on which are recorded the wave heights of tsunamis in 1946, 1952, 1957, 1960, 1964, and 1975.

A brief history of tsunamis in Hawaii since 1819 is given along with a section on the statistics of tsunami prediction.

Tsunamis in Papua New Guinea

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Australian Bureau of Mineral Resources
Port Moresby Geophysical Observatory

Science in New Guinea 4(1) 1976

Abstract

A preliminary catalogue of tsunamis for the period 1768-1975 has been compiled for the Papua New Guinea region. Information for this catalogue has been extracted from published results, local newspapers, government Administration and Public Works reports, Volcanological and Geophysical Observatory records and from reports by individuals. Fifty-eight Papua New Guinean tsunamis are listed; fifty of them occurred after 1900.

A simple precaution against tsunami damage is to construct buildings about 2-3 metres above the highest tide level.

Socioeconomic Impact of Earthquake Prediction on Government, Business and Community

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40 p. $3.00

Abstract

Research on scientifically based earthquake prediction indicates that successful prediction of a damaging earthquake in the United States could come within a few years. Findings from a research effort to determine the likely socioeconomic impact of predictions of earthquakes of varying severity are now being presented to the government, business and community organizations and to the families which took part in the NSF-RANN funded project.

During in-depth interviews, officials and family members indicated how their organization or families would respond to two different types of earthquake predictions. The total set of responses provides the basis for estimating what will happen to a community that is the focus of a credible earthquake prediction.

Principal findings include that an accurate prediction of a damaging earthquake would result in a drastic reduction in deaths and injuries and appreciable property damage reduction. However, if there were an extended lead time such as one year or more, the "target" community would suffer significant social disruption and decline in the local economy unless new or revised policies are devised to enhance the positive effects of a prediction and to counteract the negative impacts.

Earthquake Prediction, Tsuneji Rikitake. #9 in Developments in Solid Earth Geophysics series. New York: Elsevier Scientific Publishing Company, 1976. 357 p. $39.75

Abstract

The current status of earthquake prediction in Japan, the United States, the Soviet Union, and the People's Republic of China. Scientific theories upon which predictions have been, or will be based are explained with clarity. Rikitake, long involved with earthquake research in Japan, also examines legends associated with predicting earthquakes; the history of earthquake prediction; earthquake modification possibilities; and the social impacts of an earthquake prediction.

REPRINTS

Earthquake Prediction: Fact and Fallacy

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Earthquake prediction is a young and growing area in the field of seismology. Only a few years ago, experts in seismology were declaring flatly that it was impossible. Now, some successes have been achieved and more are expected. Within a few years, earthquakes may be predicted as routinely as the weather, and possibly with greater accuracy!

While science is only beginning to solve the problem, others have been claiming to be able to predict earthquakes since time immemorial. Someone has predicted a great California earthquake nearly every year. Sooner or later, one of these predictions will be right. Because wrong predictions tend to be forgotten, the result of a correct prediction could be instant fame and a great deal of potentially harmful public credulity.

The best antidote to fictional claims is a good dose of fact, but the facts will be lacking unless they are accumulated. For this reason, the U.S. Geological Survey has started keeping a file of earthquake predictions from a wide variety of sources such as newspapers, magazines, books, and letters. The method used in making the prediction is not important. Visions, psychic impressions, astrological charts, or the latest scientific theories are all added to the file. One thing which will not be considered is a prediction which is only made known after the fact. Certain well-known psychics have gained a good deal of publicity from predictions made only to close friends which were published after the event took place. Such "predictions" will not be considered by the Survey without extensive substantiation by reliable sources.

Once a valid prediction has been received, the essential details are entered into a computer storage and analysis program. Once the predicted time has passed, the list of located earthquakes is scanned for a possible match. Should the prediction prove to be correct, it receives a score based on six bits of information which could have been given: year, month, day, time, location, and size. The

score is then the number of bits correctly given divided by six. It can range from 0.00 for a clean miss to 1.00 for a perfect hit, depending on the amount of information given and the degree of accuracy. In scoring the results, a reasonable amount of leeway is allowed on time, location, and size.

Essential information on the actual earthquake that fulfills the prediction is also included in the file. The computer can sort the file chronologically or alphabetically by author of prediction. A statistical analysis can be performed at any time which gives a summary of each author's total performance to date.

The relative value of each prediction is based on the seismicity of the area in question. This is very necessary because the raw score does not give a complete picture. For example, consider two predictions. One says, "In 1977 there will be a small quake in California," and the other says, "In 1977 there will be a small quake in Florida." Each of these predictions received a score of 0.50 because each gave three correct bits of information. However, the first has a value of 0.00 and the second has a value of 0.49. Earthquakes in California are so common that any given day will probably have one, whereas Florida has so few that the odds are very much against a chance date being correct.

Once this program has been in operation for a reasonable time, it will be possible to give some sort of response to the remarkably accurate predictions which occur from time to time. We will be able to give an estimate of an author's score based on his past performance or to point out the "lucky guess" nature of a single hit. Currently, the file contains 171 predictions from 32 authors. None of the authors has achieved a high-enough rating to merit any sort of consideration.

It should be pointed out that this program does not act against anyone with real abilities. In fact, it is the best possible way to prove such an ability. Consistently accurate predictions will receive high scores and values just as impartially as consistently poor predictions will be downgraded. We are not trying to prove anything either for or against anyone. We are simply keeping score on those who claim to be able to predict earthquakes. Those individuals will stand or fall on their own records.

Participation in the program may not be used as a basis for personal gain. The Geological Survey will not endorse individuals engaged in profit-making enterprises.

Interested parties are invited to participate in the program by sending their predictions directly to us. A post-marked letter establishes the date of prediction sufficiently for our purposes and eliminates the need for some kind of publication.

Letters may be sent to: U.S. Geological Survey, Branch of Seismicity and Earth Structure, Mail Stop 968, Box 25046, Denver Federal Center, Denver, CO 80225, Attn: Roger N. Hunter

The preceding article originally appeared in the United States Geological Survey's Earthquake Information Bulletin. The editor has kindly granted persmission to reprint it here.

The Earthquake Information Bulletin is published bimonthly by the U.S. Geological Survey to provide current information on earthquakes and seismological activities of interest to both general and specialized readers. For sale by the Superintendent of Documents, U.S. Government Printing Office, Washington,D.C. 20402: annual subscription $3.00.

ANNOUNCEMENTS

Disasters

ITIC has just received the first edition of a new quarterly journal, "DISASTERS." The publication is an international journal of disaster studies and practice, both for scientists and for those engaged directly in disaster control and relief. Subscription rates, including postage, are $44 per year for libraries, and $20 per year to individuals for personal use only. Enquiries can be addressed to the Subscription Fulfillment Manager, Pergamon Press, Headington Hill Hall, Oxford OX3 OBW

V Congreso Geológico Venezolano

Informacion General

Correspondencia:

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Apartado Postal 2006
Caracas, 101
Venequela

Cuota de Inscripción:

Bs. 300,oo hasta el 31-3-77
A partir de esta fecha Bs. 400,oo

Fecha límite de Recepción de Trabajos:

1° de Septiembre de 1977

A fin de lograr una mejor distribución del programa Técnico, agradecemos a los participantes llenar la planilla anexa y enviarla a la dirección indicada. Es de primordial importancia la información sobre presentación de trabajos.

En circulares sucesivas se darán detalles sobre Programas, Temarios, Excursiones, Reservación de Hoteles, etc.

Secretaría General:

Ministerio de Minas e Hidrocarburos
Torre Norte, Piso 19
Centro Simón Bolívar
Caracas

SPECIAL ITEM

67 papers are listed in the program for the IUGG Tsunami Symposium of March 23 - 26, at Ensenada. Readers wishing a copy of abstracts or resume of papers may write to:
ITIC NEWSLETTER

Second Circum-Pacific Energy and Mineral Resources Conference, July 30 - August 4, 1978, Honolulu. HIGHLIGHTS

Although patterned after the very successful 1974 First Conference, the program for the 1978 meeting has been expanded to include more international educational

exhibits, including the new Circum-Pacific geographic maps, a special half-day symposium on environmental geology conducted by Thomas L. Wright, an evening public lecture on "Earthquakes and the Ring of Fire" by Barry Raleigh, and a pre-Conference workshop sponsored by the Circum-Pacific Council's Geoscience Training Committee.

The pre-Conference workshop from July 24 through July 28, 1978, will relate subsurface methods to basin analysis and resource appraisal. Registration probably will be limited to 100 persons, and pre-registration will be required. Details of program and necessary registration forms will be sent to interested persons who send their enquiry to: 1978 Circum-Pacific Conference; c/o AAPG; P.O. Box 979; Tulsa, Oklahoma, 74101 U.S.A.

HONOLULU OBSERVATORY REPORTS

The Honolulu Observatory, Geophysics (HO), is located near the center of a 175 acre tract at the East edge of Ewa Beach, Oahu, Hawaii. The Observatory is a Pacific Region National Weather Service field facility with programs covering a number of responsibilities relating to Geophysics. The facility consists of the Observatory building containing seismic instrumentation, communications, and a computer terminal; a shop; five homes; seismic vault; and three buildings for geomagnetic instrumentation. The 175 acres provide the essential isolation for the instruments from the surrounding cultural disturbances.

The Honolulu Observatory serves as the Tsunami Warning Center and is responsible for gathering data directly from 31 cooperative seismic stations and 50 tidal stations located throughout the Pacific in the event of an earthquake. These data are used in the analysis of tsunami potential for any earthquake in the Pacific basin. Watch and Warning Bulletins, as required, are sent to 47 dissemination points, throughout the Pacific area, where they are further distributed by local authorities to endangered areas. Press Releases are issued on significant earthquakes investigated.

The Geophysicist-in-Charge heads a staff of seven persons at HO. In addition to the Secretary, Wilda (Nona) Mazey, there are three Geophysicists: Tom Sokolowski, Joseph Zebro, Jr., and Johnny Dickey. Frank Takenouchi, Electronics Technician, and Floyd Arnold, General Mechanic, are the other members of the staff.

The four Geophysicists and the Secretary live in homes on the observatory grounds. The seismic event alarm, teletype alarm, and the phone system extends to the five homes. During non-working hours, weekends, and holidays two staff members are always on standby duty at their residences.

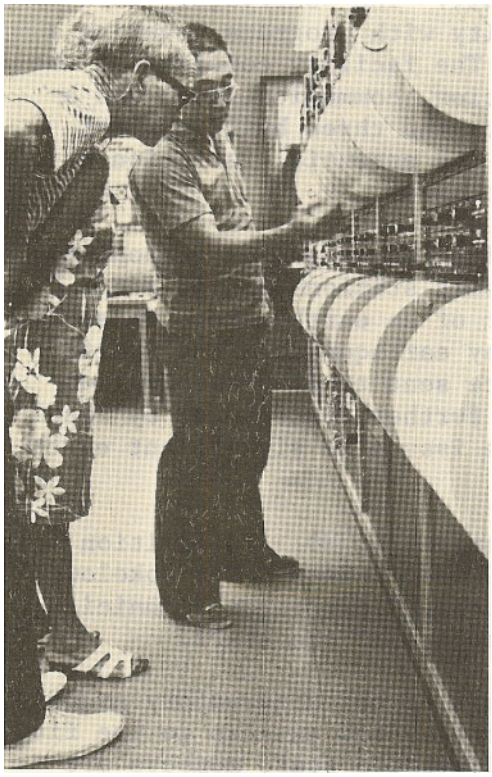
New Geophysicist-in-Charge, Honolulu Observatory

H. J. "Judd" Wirz, Jr., who has served for 10 years as Geophysicist-in-Charge of the Honolulu Observatory retired in December 1976. Newly appointed to the position is Dr. Eddie N. Bernard, who will be taking up his new duties on March 28, following the Tsunami Symposium at Ensenada. During the interim period, Mr. Joe Zebro has been Acting Geophysicist-in-Charge of the Observatory.

Dr. Bernard has been serving as a research oceanographer in the Joint Tsunami Research Effort, Honolulu and as a Lieutenant Commander in the NOAA Corps. His recent work has involved numerical modeling of tsunamis interacting with the Hawaiian Islands.

Seimic Summary, December 20, 1976 to Press Time

Date and Origin Time (UT)	Epicenter	Magnitude	Region	Comments
Dec 20 2003	49.0 N 128.8 W	6.5	Off coast, Vancouver Islands, British Columbia	Press Release Tofino Tide Gauge queried, negative wave report
Jan 06 0611	3.2 S 144.5 E	6.5	Bismarck Sea	Press Release
Feb 19 2234	51.8 N 170.6 E	6.9	Aleutian Is.	Press Release



Honolulu Observatory, and grounds, Ewa Beach, Oahu, Hawaii. Above, Mr. Frank Takenouchi, station electronics technician, explains operation of seismic recorders during recent open house. Top right, Mr. Joe Zebro, Acting Geophysicist-in-Charge, explains Tsunami Warning System to interested visitors.